CHAPTER VI

WATER STORAGE TANKS

A. PRIMARY DESIGN CONSIDERATIONS

Water storage structures shall be stable, durable, and provide protection to the quality of the stored water.

1. TYPE OF STORAGE - The choice of underground, ground level, or elevated storage depends on volume requirements, topography, hydraulic grade lines, freezing, aviation hazards, sabotage potential, and length of service lines.

2. LOCATION

   a. The bottom of ground level reservoirs and standpipes should be placed at the normal ground surface at least 1 ft (0.3 m) above finished grade and at least 1 ft (0.3) above the 100 year flood level. The finished grade of the ground surface shall slope away from the reservoir or standpipe for a distance of at least 10 ft (3.0 m) in all directions.

   b. Where the bottom must be below normal ground surface, it shall be placed above the groundwater table. At least 50 percent of the water depth should be above grade. Sewers, drains, fuel storage, standing water, and similar sources of contamination must be kept at least 50 ft (15 m) from the reservoir. Water main pipe, pressure tested in place to 50 psi (345 kPa) without leakage, may be used for gravity sewers at lesser separations, but no closer than 10 ft (3.0 m),

   c. The top of an underground reservoir can be located below the lowest frost line to minimize freeze-thaw effects on the structure. If this is done, it shall be protected from contamination by an impervious membrane.

   d. Location for finished water storage should be selected in consideration of the centers of water demand for distribution systems.

   e. No treated water storage shall be located beneath the filter pipe gallery.

   f. Finished water shall not be stored or conveyed in a compartment adjacent to untreated water when the two compartments are separated by a single wall.

g. Hydropneumatic or pressurized tanks shall be located above normal ground surface and be completely housed.

3. MATERIALS - Applicable AWWA Standards (4) should be followed for materials used in water storage facilities. Other materials of construction are acceptable when properly designed to meet the requirements of this chapter.

4. FOUNDATION

a. Foundations for elevated storage tanks, standpipes, and reservoirs must be designed and constructed to ensure uniform support and minimum settlement of the structures. Unequal settlement impacts the distribution of stresses in the structure and may cause leakage, buckling, or otherwise impair the structural integrity of the tank, standpipe, or reservoir.

b. The ultimate bearing capacity of the soil shall be determined based on sound principles of geotechnical engineering in conjunction with a properly conducted soil investigation by a qualified geotechnical engineer. The design soil-bearing pressure shall be derived from the ultimate bearing capacity by the application of an appropriate factor of safety.

5. SIZING

a. WASHWATER TANKS - Filter wash tanks shall be sized, in conjunction with available pump units and finished water storage, to provide for backwashing of more than one filter at a time or several filters in succession. The quantity of water per filter will depend upon its backwash rate and the duration of the backwash cycle.

b. CLEARWELL - Clearwell (and distribution system) storage shall be sized to relieve the filters from having to meet peak fluctuations in water demand.

c. DISTRIBUTION STORAGE - As a minimum, daily distribution system storage capacity shall be sufficient to take care of hourly variations in water demand and pressure plus the required reserve for fire protection and minor contingencies. (In the absence of metered data, peak hourly values can be assumed equal to twice the maximum daily flow or four times the average daily flow.) The minimum

storage capacity for systems not providing fire protection, like RWDs, may be reduced when the source and treatment facilities have sufficient capacity with standby power capability to supplement peak demands of the system. For either situation, storage in the distribution system shall be capable of being replenished each night during low demand periods.

Two basic kinds of distribution storage facilities exist. The most common is where finished water is pumped to elevated storage tanks or standpipes and flows by gravity into the distribution system. The second type is repumped storage which can be above ground or below ground. Depending upon the detention time, there may be a need for rechlorination with storage.

The maximum variation between high and low levels in storage structures providing pressure to a distribution system should not exceed 40 ft (12.1 m). The minimum pressure in the distribution system shall be 20 psi (140 kPa) at ground level at all points in the distribution system under all conditions of flow. The normal working pressure should be approximately 60 psi (410 kPa). When static pressures exceed 100 psi (690 kPa), pressure reducing devices should be provided on mains in the distribution system or on individual house service lines.

d. PRESSURE TANKS - Hydropneumatic tanks, when provided as the only storage facility, are acceptable only in small water systems. When serving more than 150 living units, ground or elevated storage should be provided. Pressure tank storage is not to be considered for fire protection services. Pressure tanks shall meet applicable ASME (27) requirements or equivalent requirements of state and local laws and regulations for the construction and installation of unfired pressure vessels.

Small PWSSs using wells and a pressure storage tanks should make the gross size of the hydropneumatic tank at least 10 to 15 times the capacity of the largest pump (in gpm). The proper air to liquid volume ratio should be determined to prevent excessive pump cycling operation for normal operation pressure range of 40 to 60 psig (280 to 410 kPa). Well and pump capacities should be at

least 10 times the average daily demand. A minimum of two wells and pumps should be provided for a pressure storage system. A duplicate pressure tank or by-pass piping is required to facilitate maintenance of the hydropneumatic system.

e. PRESSURIZED SYSTEMS - Pump pressurized distribution systems without storage are not recommended.

6. ROOF AND SIDEWALL - All finished water storage structures shall have suitable watertight roofs or covers which exclude birds, animals, insects, and excessive dust. The roof or cover of the storage structure shall be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports, or piping for inflow and outflow.

a. Any pipes running through the roof or sidewall of a finished water storage structure shall be welded or properly gasketed in metal tanks, or connected to standard wall castings which are poured in place during the forming of a concrete structure. These wall castings should have seepage rings imbedded in the concrete. Raw water lines or drains shall not pass through a finished water structure.

b. Openings in a storage structure roof or top, designed to accommodate control apparatus or pump columns, shall be curbed and sleeved with proper additional shielding to prevent the access of surface water to the structure. Where a cover is provided, a hasp and lock or other equivalent security means shall be provided.

c. Valves and controls shall be located outside the storage structure so that valve stems and similar projections will not pass through the roof or top of the reservoir and the reservoir will not be subject to contamination by surface water.

d. The roof or cover for the storage structure shall be well drained, but downspout pipes shall not enter or pass through the reservoir. Parapets, or similar construction which would tend to hold water and snow on the roof, will not be approved unless adequate waterproofing and drainage are provided. The roof of concrete reservoirs with earthen cover shall be sloped to facilitate drainage. Consideration should be given to installation of an impermeable membrane roof covering.

7. OVERFLOW - All water storage structures shall be provided with an overflow which is brought down to an elevation between 1 and 2 ft (0.3 and 0.6 m) above the ground surface, and discharges over a drainage inlet structure or a splash plate. No overflow may be connected directly to a sewer or a storm drain. All overflow pipes shall be located so that any discharge is visible.

   a. When an internal overflow pipe is used on elevated tanks, it should be located in the access tube. For vertical drops on the other types of storage facilities, the overflow pipe should be located on the outside of the structure.

   b. The overflow of a ground level structure shall open downward and be screened with a non-corrodible screen (1/4-inch openings) installed within the pipe at a location least susceptible to damage by vandalism or equipped with a self-closing flap gate over the discharge end.

   c. The overflow pipe shall be of sufficient diameter to permit waste of water in excess of the filling rate.

8. VENTS - Finished water storage structures shall be vented. Overflows shall not be considered as vents. Open construction between the sidewall and roof is not recommended. These vents shall incorporate a fail-safe feature such as a screen which would lift when the tank empties at a rapid rate so that air can enter the vent pipe unrestricted. Also, they shall prevent the entrance of surface water and rainwater, and exclude birds, animals, insects, rain, and dust by vent caps or other means. For elevated tanks and standpipes, 16-mesh non-corrodible screen shall be used. On ground level structures, vents should consist of inverted "U" construction, the opening of which is 2 to 3 ft (0.6 to 0.9 m) above the roof or sod and is covered with 24-mesh non-corrodible screen installed within the pipe at a location least susceptible to vandalism.

9. LEVEL CONTROLS - Adequate controls shall be provided to maintain levels in distribution system storage structures. Pumps should be controlled from tank levels with the signal transmitted by telemetering equipment. Altitude valves or equivalent devices are desirable when multiple elevated tanks exist. Overflow and low-level warning or alarms should be located at places where they will be under responsible surveillance on a 24 hr basis.

B. OTHER CONSIDERATIONS

1. ACCESS - Finished water storage structures shall be designed for convenient access to the tank interior for cleaning, maintenance, and sampling. Manholes above the waterline shall be framed at least 4 in (10 cm) and preferable 6 in (15 cm) above the surface of the roof at the opening. On ground level structures, manholes should be elevated 2 to 3 ft (0.6 to 0.9 m) above the top or covering sod. The manhole shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 in (5 cm), be hinged at one side, and have a locking device. All entryways shall be gasketed to be watertight.

2. BASINS AND WET WELLS - Receiving basins and pump wet wells for finished water shall be designed as finished water storage structures.

3. DRAIN - Storage structures which provide pressure directly to the distribution system shall be designed so they can be isolated from the distribution system and drained for cleaning or maintenance without necessitating loss of pressure in the distribution system. The drain shall discharge to the ground surface with no direct connection to a sewer or storm drain.

4. FIRE PROTECTION - Elevated storage facilities shall have adequate clearance from buildings or other combustibles, or fire-proofing shall be necessary.

5. FREEZING - All finished water storage structures and their appurtenances, especially the riser pipes, overflows, and vents shall be designed to prevent freezing which will interfere with proper functioning. Consideration should be given to heating and/or insulation of exposed pipes and valves.

6. GRADING - The area surrounding a ground level structure shall be graded in a manner that will prevent surface water from standing within 50 ft (15 m) of the structure.

7. INTERNAL CATWALK - Walkways over finished water in a storage structure are not approved by KDHE.

8. PAINTING AND/OR CATHODIC PROTECTION - Proper protection shall be given to metal surfaces by paints or other protective coatings, by cathodic protective devices, or by both. All interior coatings or paints must be certified as meeting NSF Standards for potable water and applied in conformance with the manufacturer's

recommendations and within the limitations of the NSF certification (28). After curing, the coating shall not transfer any substance to the water which will be toxic or cause T&Os. Prior to placing in service, an analysis for VOCs is advisable to establish that the coating is properly cured.

Wax coatings for the tank interior should not be used on new tanks. Recoating with a wax system is discouraged; however, the old wax coating must be completely removed to use another tank coating.

Cathodic protection should be designed and installed by competent technical personnel; a maintenance contract should be provided.

9. SAFETY - The safety of employees shall be considered in the design of storage structures. As a minimum, such matters should conform to pertinent laws and regulations of the area where the reservoir is constructed. Ladders, ladder guards, balcony railings, and safe location of entrance hatches shall be provided where applicable. Elevated tanks with riser pipes over 8 in (20 cm) in diameter shall have protective bars over the riser openings inside the tank. Railings or handholds shall be provided on elevated tanks where persons must transfer from the access tube to the water compartment.

10. SECURITY - Fencing, locks on access manholes, and other necessary precautions shall be provided to deter trespassing, vandalism and sabotage.

11. SILT PROTECTION - Discharge pipes shall be located to prevent silt from entering the distribution system. Removable silt stops are required.

12. DISINFECTION - All new, repaired, or repainted reservoirs must be disinfected according to applicable AWWA Standards (4), except method 3 of section 4.3 of Standard C652, before being placed into service. Two or more successive sets of samples, taken at 24-hour intervals, shall indicate microbiologically satisfactory water before the facilities are placed into operation.

Disposal of heavily chlorinated water from the tank disinfection process shall be in accordance with KDHE requirements.

13. PRESSURE TANKS - Each tank shall have an access manhole, a drain, and control equipment consisting of pressure gauge, water sight glass, automatic or manual air blow-off, means for adding air, and pressure-operated start/stop controls for the pumps. Where practical, the access manhole should be 2 ft (0.6 m) in diameter.

14. UNDERGROUND/GROUND LEVEL RESERVOIRS - Provide for water circulation through underground and ground level reservoirs by the use of baffles, or by placing inlets and outlets on opposite sides of the reservoir with outlets near the bottom. Valve all pipes except the overflow and provide more than one reservoir for storage during outages. Reservoirs should be drained and cleaned at intervals not greater then every two years.